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ABSTRACT

The need for management skills in engineering professions is discussed. An engineering program designed to prepare students for technical management is described and compared to a typical program granting a Master's of Business Administration. Institutions with programs are listed. (MLH)

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MANAGEMENT FOR THE ENGINEER

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MANAGEMENT FOR THE ENGINEER

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The engineer has been selected by our technical/industrial society as the individual most capable of filling its technical managerial needs. Standard operating procedure for many years has been to bring the engineer into the engineering department of the corporation and in a few years move him into managerial positions in that department or promote him into production or marketing management positions. Although this procedure was common, it became very apparent over the years that the engineer was ill-prepared for these managerial positions despite his fine technical background. He was deficient in such areas as accounting, human relations, personnel, production, marketing, managerial principles, and communication.

To combat these deficiencies during World War II and Korea, many quickie-canned managerial training programs were used. Later, companies developed various in-house training programs and used ones provided by consulting firms. Some of us were sent off to places like Harvard Business School for thirteen to sixteen weeks' advanced management programs. But all of these were somewhat "make-do" approaches. Ones like the Harvard Business School program frequently came too late in the man's career for him to take full advantage of the training.

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The seriousness of this need for management education is shown in the National Engineers Registry Survey conducted in 1969.(1) A summary of these data are shown in Figure 1.

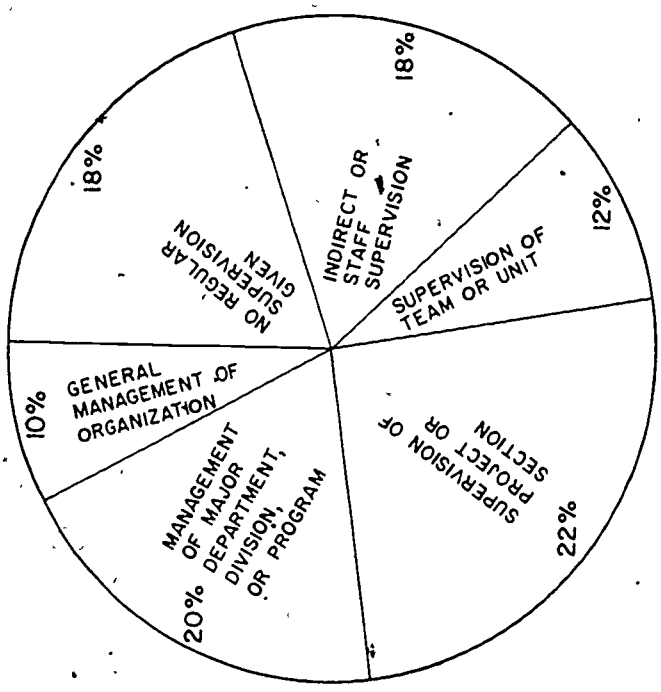

Figure 1 - Supervisory Responsibility of Engineers

In a 1972 post-censal study the National Science Foundation showed that over 480,000 persons with college degrees in engineering are reported under other occupational categories in the last census. Managers and administrators made up a large part of this group. Further, a number of articles have pointed out that half or more of the top executives in American industry today have engineering or scientific background.(2) (3)

With the apparent need for management education, let us examine what the universities have done to meet this need.

Master of Business Administration degrees have been offered for many years to fit men and women for the business world. Originially the programs

catered to the bachelor's degree in Business Administration, Humanities, and Social Science graduates. However, as it became apparent that engineers and technical personnel needed more formal training in business and management, these individuals began to enroll in such programs--frequently into night programs at their companies' urging. The business schools found the quality of their students so good they began campaigning to increase their enrollment of technical personnel. Recent surveys have shown that one out of three M.B.A. recipients holds an undergraduate degree in engineering.(4)

The result of these programs has been to make available to industry graduates, both entry level and mid-career, who were now more competent to deal with the problems of technical management. They were men now equipped with knowledge of accounting, operations research, principles of management, production, marketing, finance, personnel and general management. Frequently, they had in-depth knowledge in one of these managerial areas.

However, there were problems apparent. As is noted the M.B.A. was originally designed to take the business administration graduate and provide him with an in-depth specialty in some business area, such as finance or marketing. For a typical M.B.A. program, see Figure 2, in the Appendix. He became known for his M.B.A., his undergraduate degree tended to be forgotten, and as such he developed a distinctive degree. The last one I hired when I was in industry held an M.B.A. from Harvard but an undergraduate degree in religion. I hired him for his in-depth marketing knowledge acquired at the graduate level.

When the engineer became an important category of student, contents of the M.B.A. program did not change particularly. As a result, the

engineer's background tended to become obscured, and he found himself looked upon for his M.B.A. degree and not for his engineering degree. He found himself tending to be pulled away from his technical areas and thrust towards non-technical areas. As a result, many engineers refrained from taking an M.B.A. because they wanted to stay in technical work.

This phenomena is expressed very clearly by Dr. G. Harold Kaufman in an article in a recent issue of the New Engineer.(5) Let me quote: "In addition, most business schools do not appear interested in providing courses aimed at the technical professional . . . Many of these engineers who pursue an M.B.A. move out of technical work into such business-oriented positions as sales, marketing or general administration. Among engineering graduates who enroll in business schools, there appears to be a diminishing interest in technically-oriented courses." Recently, I attended a meeting of representatives of companies in Kansas City who had approximately 2,500 engineers in their employ. These representatives indicated that a handful of their engineers were taking M.B.A.'s because they feared they would be pulled away from their technical careers.

At the University of Missouri - Rolla in 1967 we started a somewhat different approach to the solution of this problem of preparing the engineer for technical management. Our program was directed especially at the needs of the engineer and technical man. Our aim was to keep him as a technical individual but equipped with the tools of management.

Let us take a look at our approach. (See Figure 3 in the Appendix) To insure that the men, or women, do not lose technical identification they are required to take two or three advanced graduate level courses in their field. Since engineers usually have no education in accounting or

finance, they take a two or three-course sequence of managerial accounting, managerial economics and financial management. They take one or two courses in human relations and personnel management. They receive the latest in operations research techniques and in production and marketing. They may choose other courses from some 20 elective areas. Finally, all these things are pulled together at the general management level through case studies and computer games. The total semester hours required for a non-thesis degree is 33, plus competence in programming and engineering statistics. A thesis program requires 30 hours (including 6 hours thesis).

Through these series of courses the engineer has his horizon broadened. He sees more clearly the entire corporate operation and his role in it. He becomes better prepared to be a project leader, or project manager, and supervisor in the engineering department. He is better prepared to develop and present project proposals to top management. If he opts toward production and marketing, he is prepared to serve well in those areas.

The important thing is he never forgets he is an engineer. His company still accepts him as an engineer. But, he is an engineer better able to fulfill all of the functions of an engineer.

Our own program has grown phenomenally. Kaufman[6] has reported it to be the largest graduate management program in 1973 (105 graduating). Since starting in 1967, we have graduated more than 700 men and women. They have normally received the highest salaries of the engineering graduates from the Rolla campus. They have found jobs with ease. About 60% have gone into engineering or engineering-related jobs as shown on Figure 4. More than half of the graduates have been from off-campus programs in

St. Louis and four other areas. In these programs men and women have completed their degrees in 3 to 5 years. They have been students already employed by industry.

As Dr. Kaufman reported in his article,(6) "Engineering Management programs usually required the student to have an undergraduate engineering degree. The course content is engineering oriented, even in courses given traditional M.B.A. titles . . . . Engineers who desire to remain involved in technical work but with managerial responsibilities should investigate graduate programs in engineering management." As reported by Babcock,(7) these programs generally are offered in the School of Engineering. Not all are equally as technical in their course offerings. Nevertheless, we feel that the general thrust of the 29 programs listed on Figure 5 are distinctly more technically oriented than the M.B.A. degree program, and that psychologically the man is prepared better to stay in his engineering or technical environment.

In addition to these 29 programs, there are also at least 11 programs leading to an M.S. in Management from high-technology institutions. (Figure 6). These are somewhat less technical in nature and lie somewhere between the M.B.A. and the M.S. in Engineering Management. They perhaps do not pull a man away from his engineering as strongly as the M.B.A., but on the other hand they do not strengthen his engineering posture as do the degrees in engineering management.

Still other categories of Master Degree titles bearing on the subject of management are industrial management and industrial engineering and management. The first variety are somewhat less technical than the engineering management programs and the latter are industrial engineering oriented.

In the coming years the efficient utilization of scarce resources will be more important than in the past. The need will extend beyond the industrial area into the public sector. To meet this challenge we have developed a Public Works emphasis area under our M.S. in Engineering Management degree program. (Figure 7). The first three students graduated in May, 1975 and we anticipate a significant program growth starting this fall.

When we began our program we felt that the most important thing was to transfer management knowledge to the student. As a result, we started with a non-thesis program. During the last two or three years we have begun to encourage some of our better students to do theses. The topics for the most part are practical in nature.

To lend further support to this practical thrust, we do about twenty cases per year for the Small Business Institute of the Small Business Administration. For those of you not familiar, these are real live companies with real-live problems. They normally have SBA loans and have requested help from SBA. We put 2 or 3 students and a professor on each case. The students get a first-hand look at the problems of entrepreneurship. We feel that the cases have helped us greatly to strengthen the quality of our program.

It might be mentioned in passing that our Master's is not necessarily a terminal degree. A number of our graduates have gone on to Ph.D.'s at other universities. Some have stayed with us to work on a joint Ph.D., between our department and another department.

In these days of energy, material and food crises the role of the

engineer is more important than ever before. But his full potential is unrealized in the solution of these problems unless he possesses an acquaintance with the tools of management. Technology improperly managed is only a partial loaf. I have spent two of the last four years in the Far East. There the cry in all countries is for "better management." They have what they call an "implementation gap". They say we can buy technology, hire technical men, but we can't efficiently utilize or implement the technology. They consider this their most serious and pressing problem.

And so it is with us. We need the full utilization of engineering management skills to solve these very real problems that face us. It is my hope the present twenty-nine "engineering management type" programs and those to come will help America to change these crises to opportunities.

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(3) Smith, H.E., "Undergraduate Education as Preparation For Management", Engineering Education, Vol. 59, No. 8 (April 1969) pp. 949-952.

(4) Kaufman, H. G., "Selecting a Graduate Management Program, New Engineer, September 1974, pp. 126-29

(5) Ibid

(6) Ibid

(7) Babcock, D. L., "Engineering Management Education", IEEE Transactions on Engineering Management, Vol. EM-21, No. 3, August 1974, pp. 101-104

APPENDIX

A TYPICAL MBA PROGRAM

FIRST SEMESTER	CREDIT	
Managerial Economic Analysis	3	
Public Policies Toward Business	3	
Financial Accounting: Theory & Practice	3	
Administrative Processes	3	
Computer Programming and Applications	3	
Total		15 hours

SECOND SEMESTER		
Analysis of National Economic Environment	3	
Financial Management	3	
Contemporary Marketing Concepts	3	
Statistical Analysis for Management Decisions	3	
Elective	3	
Total		15 hours

THIRD SEMESTER		
Concepts of Management Accounting	3	
Advanced Financial Management	3	
Organization Theory and Group Behavior	3	
Marketing Planning and Strategy	3	
Operations Research Methods	3	
Total		15 hours

FOURTH SEMESTER		
Production and Operations Management	3	
Policy Formulation and Administration	3	
Electives	9	
Total		15 hours
GRAND TOTAL		60 HOURS

Figure 2

MASTER OF SCIENCE IN ENGINEERING MANAGEMENT

TYPICAL PROGRAM (NON-THESIS)

PREREQUISITES:

B. S. in Engineering or Science

Programming and Engineering Statistics Competence

Graduate Level Engineering Electives	6 hrs.
Operations Research	3 hrs.
Industrial Organization & Management	3 hrs.
Managerial Accounting	3 hrs.
Financial Management	3 hrs.
Personnel Management*	3 hrs.
Production Management*	3 hrs.
Marketing Management*	3 hrs.
General Management	3 hrs.
Management Elective	3 hrs.
TOTAL	33 hrs.

* Certain of these might be replaced by other management electives to meet the needs of the individual.

Figure 3

EMPLOYMENT OF MASTER OF SCIENCE STUDENTS

BY OCCUPATIONAL TITLE

(Excluding military & continuing education)

OCCUPATIONAL TITLE	PERCENT
Production or Operations Management	5
Plant Engineering & Its Management	13
Cost or Project Engineering	20
Industrial Engineering	23
Sales Engineering	16
R & D or Systems Analysis	13
General Management & Personnel	10
	100

Figure 4

M.S. OR M. ENG. "ENGINEERING MANAGEMENT TYPE" PROGRAMS

ENGINEERING ADMINISTRATION

- Bradley University
- George Washington University
- Midwest College of Engineering
- University of Pittsburgh*
- Southern Methodist University
- Syracuse University.
- University of Tennessee at Knoxville
- University of Utah

ENGINEERING MANAGEMENT

- University of Alaska
- University of California, L.A. (Engineering Executive Program)
- University of Dayton
- Drexel University
- University of Louisville
- Milwaukee School of Engineering
- University of Missouri - Rolla
- Northeastern University
- University of Southern California*
- University of Southwestern Louisiana
- University of Tulsa
- Vanderbilt University

MANAGEMENT ENGINEERING

- University of Bridgeport
- New Jersey Institute of Tech.
- C. W. Post College
- Rensselaer Polytechnic Institute
- Worcester Polytechnic Institute

MANAGEMENT SCIENCE

- Fairleigh Dickinson University
- John Hopkins University (Evening College)
- Stevens Institute of Technology
- University of Waterloo.

*New programs

Figure 5

SOME TECHNICALLY-ORIENTED INSTITUTIONS

OFFERING M.S. PROGRAMS IN MANAGEMENT

CARNEGIE MELLON UNIVERSITY

CASE WESTERN RESERVE UNIVERSITY

FLORIDA TECHNOLOGICAL UNIVERSITY

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

GEORGIA INSTITUTE OF TECHNOLOGY

ILLINOIS INSTITUTE OF TECHNOLOGY

POLYTECHNIC INSTITUTE OF NEW YORK

PURDUE UNIVERSITY

RENSSELAER POLYTECHNIC INSTITUTE

RENSSELAER POLYTECHNIC INSTITUTE OF CONNECTICUT

VIRGINIA POLYTECHNIC INSTITUTE

Figure 6

PUBLIC WORKS MANAGEMENT

REQUIRED COURSES IN PUBLIC WORKS - 15 SEMESTER HOURS

Organization Theory

Public Works Management I and II

Public Administration

Decision Theory

MANAGERMENT ELECTIVES TO CHOOSE FROM - 6 SEMESTER HOURS

Engineering Economy

Managerial Accounting

Legal Environment

Project and Systems Management

Economic Development

Urban Sociology

Or others approved by advisor

ENGINEERING ELECTIVES TO CHOOSE FROM - 6 SEMESTER HOURS

Water Resources

Waste Water Treatment

Air Pollution Abatement

Urban and Regional Planning

Transportation and Social Systems Models

Or others approved by advisor

INTERNSHIP OR THESIS - 6 SEMESTER HOURS TOTAL - 33 HOURS

Figure 7